Mid-Term Examination, 2022

Physics Model Answer

Question 1a

i. C. T
ii. C. weight lifter
iii. B. object 2
iv. A. rotational motion
v. D. terminal velocity
vi. C. 3 and 4
vii. D. D
viii. C. 400 W
ix. B. 120 g
x. A. Pressure increases, depth increases
xi. A. Do not pollute air
xii. A. A
xiii. C. The beam rotates counter clockwise
xiv. B. $1 < 2 < 3 < 4 < 5$
xv. D. 675 N
xvi. A. J will be greater than at K
xvii. B. PQ and RS
xviii. B. When the resultant force is zero
xix. A. 5 cm
xx. D. The force is directed perpendicular to the motion of the object
xxi. D. 5 A
xxii. D. All the objects will hit the ground at the same time
xxiii. C. Pressure transmitted is equal
xxiv. B. Two times its initial value
xxv. C. unstable

Question 1b

i. B. Resultant force is zero
ii. E. Turning effect
iii. A. Maximum constant velocity
iv. C. The opposition offered to the flow of electric current
v. D. Force acting normal to the surface

Question 1c

i. Stable
ii. Compact fluorescent light (CFL)
iii. Greater or more or higher
iv. Drag force or air resistance
v. Ammeter

Question 1d

i. True
ii. True
iii. False
iv. False
v. False

Section B (60 marks)

*Attempt any **SIX** questions.*

Question 2

a. Why do dzongs have broader base? [1]

To increase the stability by lowering the position of centre of gravity (C.G)

b. Two boys weighing 60 N and 70 N sit on one side of seesaw at distances 1 m and 1.2 m respectively from the axis of rotation. Where must a third boy weighing 80 N sit in order to balance them? [2]

Counter Clock Wise moment

$$let\ F_A = 60\ N; \quad d_A = 1\ m;$$

$$Moment\ of\ F_A = F_A \times d_A$$

$$Moment\ of\ F_A = 60\ N \times 1m = 60\ Nm$$

$$let\ F_B = 70\ N; \quad d_B = 1.2\ m;$$

$$Moment\ of\ F_B = F_B \times d_B$$

$$Moment\ of\ F_B = 70\ N \times 1.2\ m = 84\ Nm$$

Clock Wise moment

$$let\ F_C = 80\ N; \quad d_C = x;$$
$$Moment\ of\ F_C = F_C \times d_C$$
$$Moment\ of\ F_C = 80\ N \times x$$

Applying Principle of moment, Total CCW moment is equal to Total CW moment, therefore

$$moment\ of\ F_A + momet\ of\ F_B = moment\ of\ F_C$$

$$60\ Nm + 84\ Nm = 80\ N \times x$$

$$144\ Nm = 80\ N\ \times x$$

$$x = 1.8\ m$$

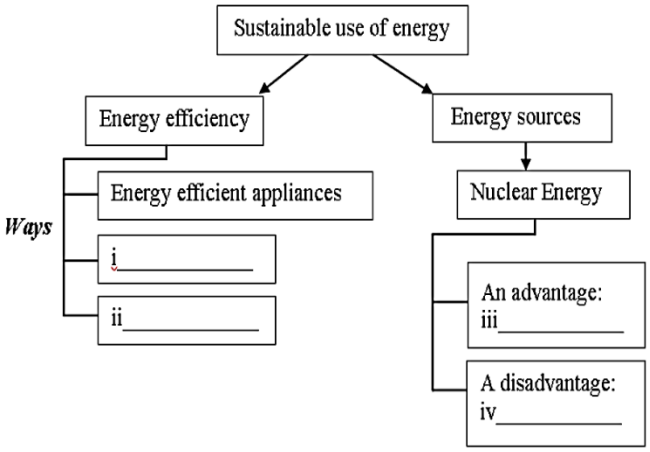
c. What are the two important motion characteristics that are true of free falling object?[1]

1. *The free falling objects do not encounter air resistance.*
   OR Drag force or air resistance = 0 ---------- *(0.5)*

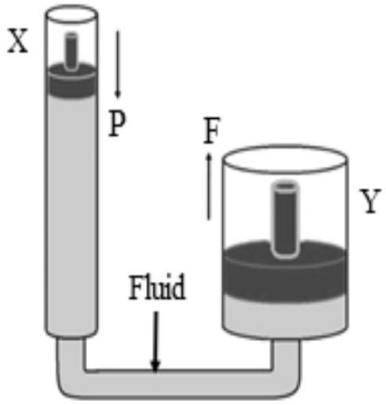
2. *On the earth, all free falling objects accelerate downwards at a rate of 9.8 m/s^2 OR g= 9.8 m/s^2* ---------- *(0.5)*

d. Complete the following flowchart. [3]

i. *Insulation*
ii. *Technology*
iii. *It is reliable. Or it releases zero carbon emissions. Or low cost of operation. Or has high energy density*
iv. *Expansive to build. Or Produces radioactive waste. Or it may lead to nuclear accident. Or workers have higher risk of developing cancer.*



e. Two cylinders **X** and **Y** are connected by a U-tube as shown in the figure below. The cross-sectional area of cylinder **Y** is greater than that of **X**.



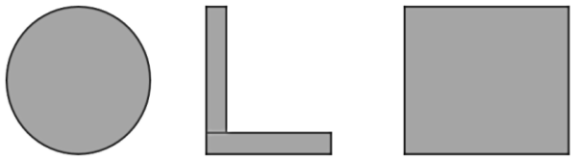
i. Which cylinder will exert more pressure? Why? [1]
Pressure exerted by cylinder X and Y are equal. This is due to Pascal's law.

ii. What is the function of the fluid used in the system?[1]
Fluid transmits the pressure exerted equally and undiminished throughout the mass of the fluid.

f. As an observation to the flow of electric current, resistance of a wire depends on several factors. Mention **TWO** ways to have a maximum current flowing through a wire. [1]
Decreasing length of the conductor, increasing the thickness of the conductor, and decreasing the temperature of the conductor, decreases resistance of the conductor resulting in the increasing current.

Question 3

a. Three objects of different shapes are cut from the same sheet of metal as shown below.



Do you think the centre of gravity in all the shapes lie on the body? Justify with an example. [1]
No, for a disc and square shape object, the C.G will lie on the on the body. However, for the L shaped object the C.G will lie away from the body.

b. A force of 20 N is applied to a door causing a moment of 5 Nm. Calculate the distance in **'cm'** from the hinge axle to the point on the door where the force is applied. [2]

$$Force, F = 20\ N; \quad moment\ of\ force = 5\ Nm; \quad d = ?$$

$$d = \frac{moment\ of\ force}{Force}$$

$$d = \frac{5}{20} = 0.25\ m = 25\ cm$$

c. What are the forces acting on the falling object and free falling object? [1]
For falling object: drag force or air resistance and gravity or weight
For free falling object: gravity or weight

d. A pulley is used during the construction of a building to lift a 100 kg load of bricks through a vertical height of 16 m in 20 s. Find the efficiency of the pulley if its power input is 1000 W. [3]

$$mass\ of\ the\ brick, m = 100kg;$$

$$Load = m \times g = 100 \times 10 = 1000\ N$$

$$dL = 16\ m; \quad time\ taken = 20\ s$$

$$Output\ power = \frac{Output\ Workdone(L \times dL)}{time\ taken}$$

$$Output\ power = \frac{1000\ N \times 16\ m}{20\ s} = 800\ W$$

$$input\ power = 1000\ W$$

$$Efficiency = \frac{Output\ Power}{Input\ Power}$$

$$Efficiency = \frac{800\ W}{1000\ W} = 0.8$$

$$Efficiency\ \% = 80\ \%$$

e. A 250 N solid cube which has a side of 20 cm was placed on the floor. What is the pressure exerted by the cube on the floor?[2]

$$Force, F = 250\ N; \quad length = 0.2\ m; \quad width = 0.2\ m$$

$$Contact\ area, A = length \times width$$

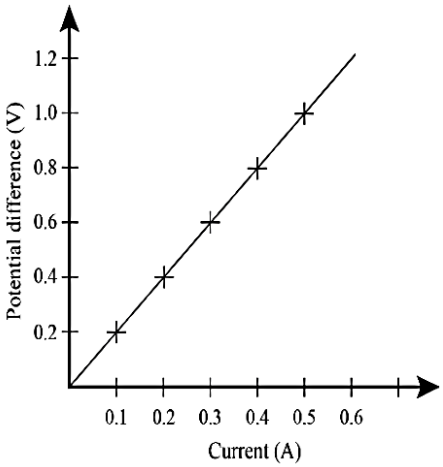
$$A = 0.2\ m \times 0.2\ m = 0.04\ m^2$$

$$Pressure\ exerted\ by\ cube\ on\ the\ floor, P = \frac{F}{A}$$

$$P = \frac{250\ N}{0.04\ m^2}$$

$$P = 6250\ Pa$$

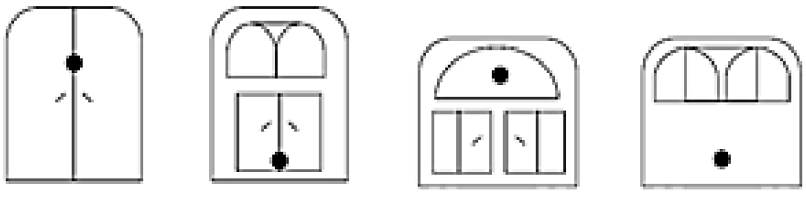
f. Name the I-V graph of a nichrome wire as shown in the figure. Name the law and constant variable illustrated by the graph. [1]



Name of the law: Ohm's Law.
The constant variable: Resistance or temperature and pressure

Question 4

a. The figure below shows four different designs of truck A, B, C and D with their centre of gravity marked with a dot (●)



A B C D

Which design of truck is the most stable? Give reason for your answer. [1]

Truck B is more stable because its centre of gravity is toward the base. Lower is the position of C.G, higher is the stability.

b. Karma applies a force of 4 N on a handle that is about 1.5 m away from door hinge. Calculate the moment of force.[2]

$$Force, F = 4\ N; \quad Displacement, d = 1.5\ m$$

$$moment\ of\ force = F \times d$$

$$Moment\ of\ force = 4\ N \times 1.5\ m = 6\ Nm$$

c. Why do sky drivers use parachutes? [1]

The parachute increases the body's surface area, and this increased air resistance or drag force slows the body in motion.

d. Is solar a reliable and powerful enough to be used in homes or businesses? [3]

Open ended

e. Why must a liquid and not a gas be used as 'fluid' in a hydraulic machine? [2]

A liquid is used as a hydraulic fluid because it is incompressible, making it easier for the pressure to transfer whereas gas is compressible, it only gets smaller without transferring the pressure.

f. An air-conditioner in Gelephu operates on a 220 V circuit and draws 10 A current. Determine the power rating of such a conditioner. [1]

$$voltage, V = 220\ V; \quad Current, I = 10\ A; \quad Power, P = ?$$

$$P = IV$$

$$P = 10\ A \times 220\ V = 2200\ Watt$$

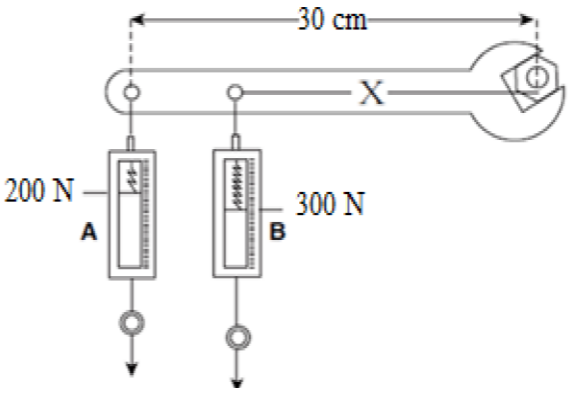
Question 5

a. What are factors determining stability of the body? [1]

i. Position of centre of gravity (C.G)

ii. Base support area

b. In the diagram given below, a force meter **A** was used on a spanner to loosen a nut and it reads 200 N. Force meter **B** was then used to loosen the nut and it reads 300 N. What is the distance **X** in the figure?[2]



$$let\ F_A = 200\ N; d_A = 30\ cm$$

$$F_B = 300\ N;\ d_B = x$$

$$moment\ of\ F_A = F_A \times d_A$$

$$moment\ of\ F_A = 200\ N \times 0.3\ m = 60\ Nm$$

$$moment\ of\ F_B = F_B \times d_B$$

$$moment\ of\ F_B = 300\ N \times x$$

Applying principle of moment, Moment of F_A is equal to Moment of F_B, therefore,

$$60\ Nm = 300\ N \times x$$

$$x = \frac{60\ Nm}{300\ N} = 0{,}2\ m = 20\ cm$$

c. The weight of a body and air resistance are the two main forces acting on the free falling object. What will happen if the two forces are equal? [1]
The object will reach a maximum constant velocity called terminal velocity.

d. While hydropower is the backbone of Bhutanese economy, the method of power generation has impacts on the environment. Mention **THREE** negative environmental impacts of hydroelectricity on the environment. [3]

i. ***Occupies large area*** *due to construction of dams and reservoirs.*
ii. *Natural flow of water, nutrients and sediments may be disturbed affecting* ***agriculture and habitats of wildlife****.*
iii. ***Obstruct the migration of fishes*** *affecting both aquatic and terrestrial plants and animals.*

e. A swimming pool of width 9.0 m and length 24.0 m is filled with water to depth of 3.0 m. Calculate the pressure on the pool due to the water (density of water is 1000kg/m^3).[2]

$$depth, h = 3\ m; \quad density\ of\ water, d = 1000\ kgm^{-3};$$

$$acceleration\ due\ to\ gravity, g = 10\ ms^{-2}$$

$$pressure = hdg$$

$$pressure = 3 \times 1000 \times 10$$

$$pressure = 30{,}000\ Pa$$

For, $g = 10\ ms^{-2}$, pressure is 29,400 Pa

f. State Ohm's law.[1]

The current flowing through any cross-section of the conductor is directly proportional to the potential difference applied across its ends, provided physical conditions like temperature and pressure are constant.

OR $V \propto I, when\ R = constant$

Question 6

a. What is the difference between stable and unstable equilibrium? [1]

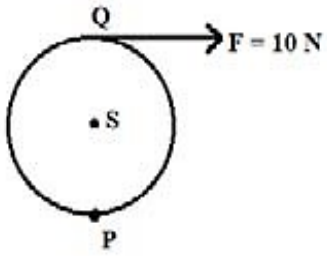
Stable equilibrium	**Unstable equilibrium**
The body is able to regain its original position after being slightly disturbed.	The body is not able to regain its original position after being slightly disturbed.
The line of C.G passes through area of base of support.	The line of C.G does not pass through area of base of support.

b. What is the difference between free falling object and falling object? [1]

Free Falling Object	***Falling Object***
Air resistance or drag force is 0	*Air resistance or drag force is not 0*
Only gravity or weight acts on the body.	*Gravity and drag force acts on the body.*
Size, shape and mass does not affect the free falling object.	*Size, shape and mass affect the falling object.*
All the free falling object reaches the ground at the same time when dropped from the same height.	*All the falling object reaches the ground at the same time when dropped from the same height.*

c. Show how energy is conserved in a freely falling body with the help of a diagram. [3]
Refer the Textbook on page number 52

d. A wheel of diameter 2 m is shown in the figure below with axel at **S**. if the 10 N force is applied at the point **Q**, calculate the moment of force about



i. point S [1]

$$moment\ of\ froce = F \times d$$

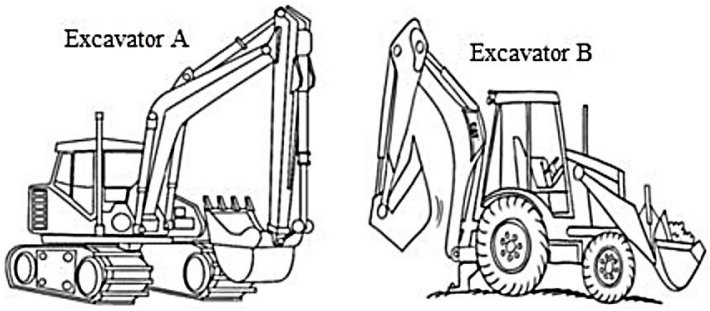
$$= 10\ N \times 1m = 10\ Nm$$

ii. point P [1]

$$moment\ of\ froce = F \times d$$

$$= 10\ N \times 2m = 20\ Nm$$

e. Two different types of excavators with the same mass are shown in the figure.



Using the concept of pressure, explain which excavator is best suitable to operate on a muddy ground? [2]

Excavator A**: It has **more surface area in** contact with the muddy ground. It exerts **less pressure.

f. What is the conventional direction of electric current? [1]

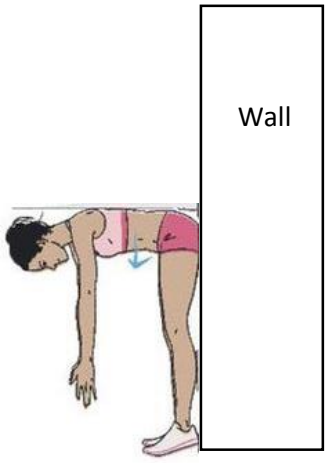
The conventional direction of electric current is from positive to negative terminal of the battery. Or from high potential region to low potential region of the battery.

Question 7

a. Do you think you could bent to touch your toes with legs held straight against the wall? Explain why. [1]

Yes, I remain stable while bending in order to touch my toes because line of C.G is passing through my feet.

No, I become unstable while bending in order to touch my toes because line of C.G is not passing through my feet.



b. Why is it easier to open a door by holding it from its edge? [2]

Moment of force depends on distance from the point of rotation. When held at the edge of the door, distance is increases, increasing moment. When the distance is more, the required force to open the door is less. Hence, making it easier to open the door.

c. What will happen to the magnitude of drag force as the falling object speeds up? [1]

Magnitude of drag force exerted on the falling object will ***increase*** *as it speed up.*

d. In a hydraulic lift, the 120 N of input force is required to lift 3600 N of weight of the block. What is the ratio of smaller piston to larger piston?[2]

$$Input\ force, F_1 = 120\ N; Out\ put\ force, F_2 = 3600\ N$$

Ratio of smaller piston to larger piston is $A_1 : A_2$

$$\frac{A_1}{A_2} = ?$$

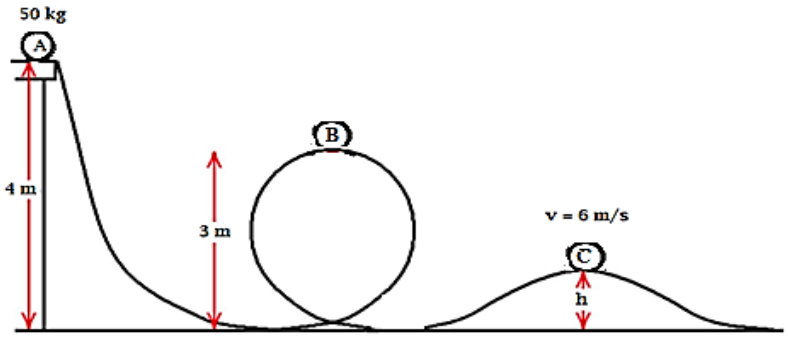
Applying Pascal's law, $\frac{A_1}{A_2} = \frac{F_1}{F_2} = \frac{120\ N}{3600\ N} = \frac{1}{30}$

$$\frac{A_1}{A_2} = \frac{1}{30}$$

e. State **TWO** factors affecting resistance of a conductor.[1]

Temperature, length of the wire, thickness of the wire, nature of the material

f. A figure below shows a freely falling body which obeys conservation of energy. Determine the value of **h**. [3]



At position A

$$Total\ M.E = mgh = 50 \times 10 \times 4 = 2000\ J$$

At position B

$$K.E = \frac{1}{2}mv^2 = 0.5 \times 50 \times 6^2 = 900\ J$$

$$G.P.E = mgh = 50 \times 10 \times h = 500\ h$$

$$T.M.E = K.E + G.P.E$$

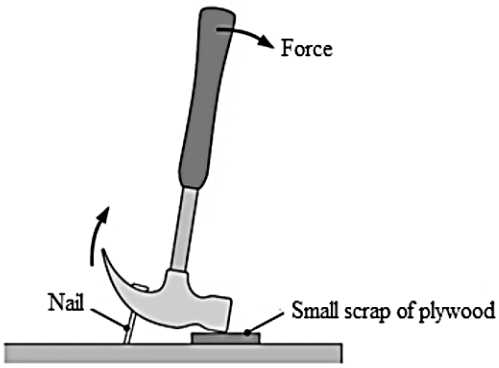
$$2000\ J = 900\ J + 500\ h$$

$$h = \frac{1100}{500} = 2.2\ m$$

Question 8

a. Why would you advice a person to sit rather than stand in a moving bus?[1]
The position of centre of gravity is high and the stability is less.
When a person sits the position of C.G is lowered, increasing the stability of the body.

b. A carpenter is removing the nail from a wooden plank using a hammer as shown in the figure below.



Suggest **TWO** ways to increase the moment of force so that he can extract the nail easily.[2]
Increasing the distance of point of application of force.
Increasing the magnitude of force

c. What factors can influence the falling object on the Earth?[1]
Drag force,, gravity

d. A box weighing 100 N is pushed up an inclined plane that is 5 meters long. It takes a force of 75 N to push it to the top, which has a height of 3 meters. Calculate the efficiency of an incline plane. [3]

$$Input\ force, E = 75\ N; \quad Output\ force, L = 100\ N; \quad dL = 3\ m; \quad dE = 5m$$

$$Efficiency = \frac{Output\ workdone}{Input\ workdone}$$

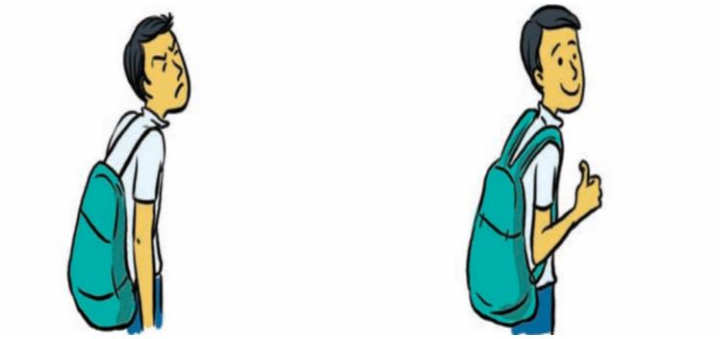
$$Efficiency = \frac{L \times dL}{E \times dE}$$

$$Efficiency = \frac{100\ N \times 3\ m}{75\ N \times 5m} = \frac{300\ J}{375\ J} = 0.8$$

$$Efficiency\ \% = 80\ \%$$

e. Write the S.I unit of resistance and electric current.[1]
Resistance: Ohm
Electric current: Ampere

f. Which one of the following bags will students prefer to carry books to school? Explain why. [2]



a) A bag with a narrow strap

b) A bag with a broad strap

The students will prefer a bag with a broad strap. This is because broad strap means more surface area in contact. This decreases pressure exerted on the shoulders.